

First record of an *Andricus* chestnut gall wasp from the Oriental Region: a new species from China (Hymenoptera: Cynipidae: Cynipini)

Juli PUJADE-VILLAR¹, Rui GUO², Yiping WANG^{3①}, Mar FERRER-SUAY⁴

1. Department of Animal Biology, Barcelona University, Barcelona 08028, Spain

2. Administration Bureau of Zhejiang Qingliangfeng National Nature Reserve, Lin'an, Zhejiang 311300, China

3. College of Forest and Biotechnology, Zhejiang Agricultural and Forestry University, Lin'an, Zhejiang 311300, China

4. Department of Zoology, Faculty of Biological Sciences, University of Valencia, Burjassot-Paterna Campus, Burjassot 46100, Spain

Abstract: A new species of gall wasps, *Andricus henryi* Pujade-Villar, Wang & Guo sp. nov. is described on *Castanea henryi* from China. Additionally, the first gall wasp host of *Synergus castanea* is mentioned. Diagnosis, distribution, and biology of this new species are included and illustrated. A species of *Andricus* is mentioned for the first time in a *Castanea* host.

Key words: gall wasp; taxonomy; biology

中国新纪录属——致瘿栗属植物的纹瘿蜂属并记一新种（膜翅目：瘿蜂科：瘿蜂族）

Juli PUJADE-VILLAR¹, 郭瑞², 王义平^{3①}, Mar FERRER-SUAY⁴

1. Department of Animal Biology, Barcelona University, Barcelona 08028, Spain; 2. 浙江清凉峰国家级自然保护区管理局, 浙江 临安 311300; 3. 浙江农林大学林业与生物技术学院, 浙江 临安 311300;

4. Department of Zoology, Faculty of Biological Sciences, University of Valencia, Burjassot-Paterna Campus, Burjassot 46100, Spain

摘要: 记述中国瘿蜂科纹瘿蜂属 1 新种：锥栗纹瘿蜂 *Andricus henryi* Pujade-Villar, Wang & Guo sp. nov., 该种致瘿于壳斗科的锥栗上，并首次发现其寄瘿瘿蜂为栗客瘿蜂 *Synergus castaneus* Pujade-Villar, Bernardo & Viggiani, 2013。本文报道该新种的鉴别特征、分布及生物学。

关键词: 瘿蜂; 分类; 生物学

Introduction

Species of the family Cynipidae (Hymenoptera: Cynipoidea) are exclusively phytophagous gall wasps. The most important group in this family belongs to the tribe Cynipini, the so-called gall makers on Fagaceae. The tribes Synergini and Ceroptresini group inquiline of these gall wasps according to Ronquist *et al.* (2015). Inquilines were ability to

Accepted 2 May 2018. Published 25 June 2018. Published online 11 June 2018.

① Corresponding author, E-mail: wyp@zafu.edu.cn

modify the gall tissue directly surrounding them into characteristic nutritive tissue, also found in the larval chambers of the gall inducer, but they have lost the ability to begin the gall. Nevertheless, a few inquiline species are mentioned as gall forming or probably gall forming (Abe *et al.* 2011; Liu *et al.* 2012; Bernardo *et al.* 2013).

The cynipid gall wasp fauna of the Eastern Palaearctic and Oriental Region is poorly known (Abe *et al.* 2007). Only 51 valid species are recognized from the Eastern Palaearctic and Oriental areas, mostly from Taiwan of China, Japan and the Russian Far East (Abe *et al.* 2007; Melika *et al.* 2009, 2010, 2011, 2013; Pujade-Villar *et al.* 2014; Tang *et al.* 2009, 2011a, b, 2012a, b; Wang *et al.* 2016). Currently, 13 species of cynipid gallwasps, associated with Fagaceae, are known from the mainland of China (Wang *et al.* 2013; Pujade-Villar *et al.* 2016; Zhu *et al.* 2015): *Andricus deqingis* Wang, Guo & Chen 2013, *A. flavus* Pujade-Villar, Wang, Guo & Chen 2014, *A. kashiwaphilus* Abe 1988, *A. mairei* (Kieffer 1906), *A. mukaigawae* (Mukaigawa 1913), *A. pseudoflos* (Monzen 1954), *A. targionii* Kieffer 1903, *A. xishuangbannaus* Melika & Tang 2012, *Biorhizanawai* (Ashmead 1904), *Dryocosmus kuriphilus* Yasumatsu 1951, *D. zhuli* Liu & Zhu 2015, *Trichagalma serratae* (Ashmead 1904) and *T. acutissimae* (Monzen 1953) (= *T. glabrosa* Pujade-Villar 2012 according to Wang *et al.* 2016).

In the North-Eastern of the Palaearctic Region, two species belonging to the genus *Dryocosmus* occur on host plants of *Castanea* spp. (Fagaceae) (Zhu *et al.* 2015): *D. kuriphilus* and *D. zhuli*. *Dryocosmus kuriphilus* has been accidentally introduced into the Northern Hemisphere and is now a serious pest of chestnut trees in North America and Europe. In addition, according to Schwéger *et al.* (2015a, b), only an inquiline species has been mentioned in *Castanea* host gall wasps: *Synergus castaneus* Pujade-Villar, Bernardo & Viggiani (2013).

In this work, the first *Andricus* species in chestnut is described and the first gall wasp host from *Synergus castaneus* is noted.

Material and methods

The current terminology of the cynipid gallwasp morphology follows Liljeblad & Ronquist (1998) and Melika (2006). Abbreviations for the forewing venation are taken from Ronquist & Nordlander (1989) and the cuticular surface terminology follows Harris (1979). Measurements and abbreviations used here include: F1–F12, first and subsequent flagellomeres; post-ocellar distance (POL) is the distance between the inner margins of the posterior ocelli; ocellar–ocular distance (OOL) is the distance from the outer edge of the posterior ocellus to the inner margin of the compound eye; LOL, the distance between lateral and frontal ocelli. The width of the forewing radial cell was measured from the margin of the wing to the Rs vein.

Scanning electron microscope (SEM) images of some described species were taken with a Leica Stereoscan-360 at high voltage (15 kV) without gold coating in the “Serveis de Microscopia Electrònica” at Barcelona University (UB).

The Chinese specimens collected in Zhejiang and Shaanxi Provinces are deposited in the Hymenoptera Collection of Zhejiang Agricultural and Forestry University (ZAFU) and at Barcelona University (UB).

Taxonomy

1. *Andricus henryi* Pujade-Villar, Wang & Guo nov. sp. (Figs. 1–3)

Holotype. ♀, deposited in UB with the following labels: “Qianqingtang Village (Qingliangfeng National Nature Reserve, Zhejiang Province), ex *Castanea henryi*, (03-IV-2016) 15-IV-2016, col. Guo Rui” (white label); “*Andricus henryi* Pujade-Villar, Wang & Guo nov. sp., desig. JP-V 2017” (red label). **Paratypes.** 13♀, same data as holotype: 7♀ ZAFU, 6♀ UB.

Diagnosis. *Andricus henryi* resembles the known Taiwanese *A. pseudocurvator* Tang & Melika, 2011 in having black body, mesoscutum smooth and lateral propodeal carinae diverging but curved-angled outwards in posterior 1/4. In *A. henryi* OOL is around 2.0× as long as lateral ocellus; F1 around 1.5 times as long as F2 and longer than pedicel; placodeal sensilla present in F2–F11; second metasomal tergite occupying more than half of metasoma in dorsal view; the prominent part of the ventral spine of the hypopygium is shorter, only 3.0× longer than broad, where as in *A. pseudocurvator* OOL is around 3.0× length of lateral ocellus; F1 shorter, 1.2 times as long as F2 nearly equal to length to pedicel; placodeal sensilla absent in F1–F2; second metasomal tergite occupying 1/3–1/2 of metasoma in dorsal view; the prominent part of the ventral spine of the hypopygium 6.0 times as long as broad. Galls of *A. henryi* occur in *Castanea*, whereas the galls of *A. pseudocurvator* are in *Quercus serrata* Murray (= *Q. glandulifera* Blume) (section *Quercus* sensu stricto).

Female.

Length. Body length 2.1–2.3 mm. ($n = 5$)

Color. Head, mesosoma and metasoma entirely and uniformly very dark brown to black; clypeus and mandibles brown; scape, pedicel, F1–F5 light brown, subsequent flagellomeres progressively darkening until tip; maxillary and labial palpi brown; tegula brown; legs uniformly brown, with coxae II–III darker at the base; ventral spine of hypopygium dark brown.

Head (Figs. 1a, b). Triangular in frontal view, weak alutaceous, with some white setae on lower face; 2.4× broader than long from above, 1.3× broader than high, as broad as mesosoma in anterior view. Gena delicately alutaceous to smooth, not broadened behind eye, as long as cross diameter of eye; malar area with delicate striae not extending to eye margin, 0.3× as long as height of eye. Inner margins of compound eyes nearly parallel. POL around 1.4× broader than OOL; OOL 1.9× longer than length of lateral ocellus, and 1.6× longer than LOL; all ocelli of same size and shape (POL : OOL : OCO = 50 : 35 : 22, diameter of lateral ocellus 18). Transfacial distance only 1.2× wider than height of eye; diameter of antennal toruli slightly shorter than distance between them, distance between torulus and inner margin of eye nearly equal to diameter of torulus; lower face, including slightly elevated median area coriaceous, with some white setae. Clypeus emarginate, slightly incised ventrally, weak alutaceous, glabrous; anterior tentorial pits, epistomal sulcus and clypeo-pleurostomal line distinct, deep. Frons smooth, glabrous and shiny; interocellar area coriaceous. Vertex and occiput coriaceous, shiny.

Antenna (Fig. 1c). With 11 flagellomeres, F10 2× in length to F11 (suture in F11–F12 absent, in some paratypes with an indistinct suture present and antenna seems to have 12

flagellomeres); $1.3\times$ as long as head+mesosoma; pedicel as long as broad; F1 $1.45\times$ longer than F2, $2.0\times$ longer than pedicel; F2–F11 progressively shorter; F11 2.1 times longer than F10 (if a suture present, then F12 equal to F11); placodeal sensilla present on F2–F11, absent on F1. Antennal formula: 11 : 10 : 21 : 15 : 12 : 12 : 12 : 11 : 11 : 10 : 10 : 9 : 19.



Figure 1. *Andricus henryi*, ♀. a. Head, frontal view; b. Head, dorsal view; c. Antennae; d. Body, lateral view; e. Tarsal claws.

Mesosoma (Figs. 2a–c). $1.1\times$ longer than high. Pronotum weak alutaceous to smooth, shiny, with some delicate parallel striae laterally and some white setae. Mesoscutum smooth, shiny, with few white setae along notauli and anterior area; $1.2\times$ wider than long (largest width

measured across mesoscutum at level of base of tegulae). Notauli complete, deep, distinctly impressed, slightly converging at posterior end and wider apically and basally; anterior parallel, parapsidal, median mesoscutal lines absent. Mesoscutellum longer than broad, rugose less impressed in the centre, overhanging metanotum; scutellar foveae distinct, transversely ovate, 2.0× broader than high, with smooth, shining bottom, separated by a short median carina. Mesopleuron and speculum smooth, shining, without setae, except a small patch of setae on posteroventral quarter of mesopleuron; with impressed foveae along acetabular carina; dorsal axillar area smooth, shining, with dense white setae; lateral axillar area alutaceous, with very few setae; subaxillular bar smooth, shiny, most posterior part broader, as broad as height of metanotal trough; postalar process with parallel delicate striae; metapleural sulcus reaching mesopleuron at one-third of its height. Metascutellum uniformly coriaceous with some weak rugae, metanotal trough smooth, shiny, with short white setae; ventral impressed area short, smooth, without pilosity; central propodeal area smooth, shiny, without irregular wrinkles and rugae or only basally, lateral propodeal carinae strong, high, divergent bud strongly curved outwards in posterior half; lateral propodeal area coriaceous, with dense long, white setae. Nucha short, with irregular wrinkles and rugae.

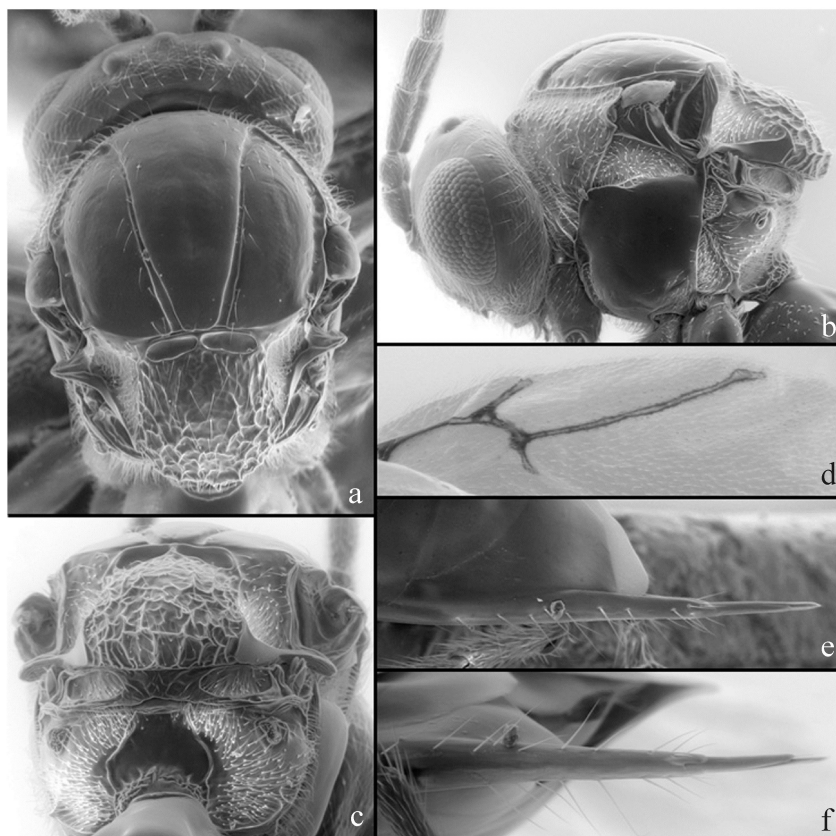


Figure 2. *Andricus henryi*, ♀. a. Mesosoma, dorsal view; b. Mesosoma, lateral view; c. Propodeum; d. Radial cell, forewing; e. Ventral spine of hypopygium, lateral view; f. Ventral spine of hypopygium, ventral view.

Legs. Tarsal claws with rounded basal lobe (Fig. 1e).

Forewing. Longer than body, hyaline, with distinct long, dense cilia on margin, radial cell $4.2\times$ longer than wide (Fig. 2d); R1 reaching wing margin, Rs nearly straight, not reaching wing margin; areolet small, triangular, closed and distinct. Rs+M distinct at two-thirds of distance to basalis and its projection reaching basalis at middle.

Metasoma (Fig. 1d) slightly shorter than head+mesosoma, as high as long in lateral view; second metasomal tergite occupying at least $1/2$ of metasoma in dorsal view, with some white setae laterally, all subsequent tergites without setae, smooth, shiny, without micropunctures. Hypopygium without micropunctures, ventral spine (Figs. 2e, f) of hypopygium relatively short, prominent part $3.0\times$ longer than broad, with a line of white setae ventro-laterally, with white subapical setae not extending beyond apex of spine.

Male. Unknown.



Figure 3. Gall of *Andricus henryi* on *Castanea henryi*.

Gall (Figs. 3a, b). Plurilocular gall, integrated into twigs, tuberous. The entire gall is

approximately spherical, 9–15 mm in diameter ($n = 10$), sometimes buds or young shoots are observed on the surface. Outer wall of larval chamber attaches to the inner lignicolous wall of surrounding gall tissues. Young gall is fleshy, green, turning dry and dark brown when mature.

Biology. Only the female is known. Based on the adult morphology and the gall phenology, the female probably represents the sexual generation, which induces integral twin galls on *Castanea henryi* Rehder & E. H. Wilson, 1916. The galls appear in October, mature in early April, and adults emerge in the same month. Galls collected appear in the previous year.

Distribution. Currently known from Qingliangfeng National Nature Reserve, Zhejiang Province, China. Similar galls were collected in Jinzhai (Anhui Province) on *Castanea mollissima* Blume and *C. seguinii* Dode, according to Bernardo *et al.* (2013). Although further research is necessary to establish the distribution of this species, probably it is distributed in Eastern Palaearctic throughout the range of its host.

Gall associates. Several parasitoids (Chalcidoidea) belonging to the families Eulophidae, Eurytomidae (*Eurytoma* and *Sycophila*) and Torymidae (*Megastigmus*), and the inquiline *Synergus castaneus* (Cynipidae: Synergini) emerged.

Etymology. The specific epithet relates to the specific name of the chestnut host where it is collected.

2. *Synergus castaneus* Pujade-Villar, Bernardo & Viggiani, 2013

Synergus castaneus Pujade-Villar, Bernardo & Viggiani, 2013, 106(4): 437.

Specimens examined. 113♂102♀, Qianqingtang Village (Qingliangfeng National Nature Reserve, Zhejiang Province), ex *Andricus henryi* galls on *Castanea henryi*, col. Rui GUO, (03-IV-2016) 15–30-IV-2016: 53♂22♀; idem 01–15-V-2016: 55♂67♀ (9♂10♀ UB); idem 16–30-V-2016: 5♂13♀.

Discussion

Recently, the supposed inquiline nature of all Synergini has been questioned by the discovery of two new species: (i) *Synergus itoensis* Abe, Ide & Wachi, 2011, recorded in Japan on *Quercus glauca* (Thunb.), which has been demonstrated to be a gall inducer (Abe *et al.* 2011) and (ii) *S. hupingshanensis* (Liu *et al.* 2012) which was inferred to be a gall maker because no gall maker was reared from the same galls. In the same way Bernardo *et al.* (2013) affirmed, when *S. castaneus* was described, that “after we do not find any Cynipid between several hundreds of *S. castaneus* collected, the possibility that this species is a gall inducer cannot be ruled out”.

After our results, we find *S. castaneus* is not a gall-inducer species. It appears at least for *Andricus henryi* galls on *Castanea henryi*. The gall pictured in Bernardo *et al.* (2013, Fig. 17) is identical to the Fig. 3b (in this paper) so we have no doubts that these galls are the same. Therefore, according to this evidence, *S. castaneus* is an inquiline of *A. henryi* in *C. henryi*, *C. mollissima* Blume and *C. seguinii* Dode. In addition, our data confirm that the gall inducer *A. henryi* is strongly attacked by the inquiline species, and therefore the adults of *Andricus* are very poorly collected in relation to the number of galls. This situation is not new in gall formers; the European species *Andricus legitimus* Wiebes-Rijks, 1980 has a survival of 0.01–0.02% in confronting inquilines and parasitoids (Wiebes-Rijks 1980), and being 60–85%

for *Synergus clandestinus* Eady, 1952.

Synergus castaneus is a Chinese species located on several species of *Castanea* in Anhui and Zhejiang Provinces, according to our current understanding.

Acknowledgements

The study was supported by the Zhejiang Provincial Natural Science Foundation for Distinguished Young Scholars (LR14C040002) and the National Natural Science Foundation of China (31472032, 31071970).

References

- Abe Y, Ide T & Wachi N. 2011. Discovery of a new gall-inducing species in the inquiline tribe Synergini (Hymenoptera: Cynipidae): inconsistent implications from biology and morphology. *Annals of the Entomological Society of America*, 104: 115–120.
- Abe Y, Melika G & Stone GN. 2007. The diversity and phylogeography of cynipid gallwasps (Hymenoptera: Cynipidae) of the Oriental and Eastern Palaearctic Regions, and their associated communities. *Oriental Insects*, 41: 169–212.
- Bernardo U, Gebiola M, Xiao Z, Zhu D, Pujade-Villar J & Viggiani G. 2013. Description of *Synergus castaneus* n. sp. (Hymenoptera: Cynipidae: Synergini), associated with an unknown gall on *Castanea* spp. (Fagaceae) in China. *Annals of the Entomological Society of America*, 106(4): 437–446.
- Harris R. 1979. A glossary of surface sculpturing. State of California, Department of Food and Agriculture. *Occasional Papers of Entomology*, 28: 1–31.
- Liljeblad J & Ronquist F. 1998. A phylogenetic analysis of higher-level gall wasp relationships (Hymenoptera: Cynipidae). *Systematic Entomology*, 23: 229–252.
- Liu Z, Yang XH, Zhu DH & He YY. 2012. A new species of *Saphonecrus* (Hymenoptera, Cynipoidea) associated with plant galls on *Castanopsis* (Fagaceae) in China. *Annals of the Entomological Society of America*, 105(4): 555–561.
- Melika G. 2006. Gall wasps of Ukraine. Cynipidae. *Vestnik Zoologii*, supplement 21(1-2): 1–300, 301–644.
- Melika G, Pujade-Villar J, Abe Y, Tang CT, Nicholls J, Wachi N, Ide T, Yang MM, Péntzes Z, Csóka G & Stone GN. 2010. Palaearctic oak gall wasps galling oaks (*Quercus*) in the section *Cerris*: re-appraisal of generic limits, with descriptions of new genera and species (Hymenoptera: Cynipidae: Cynipini). *Zootaxa*, 2470: 1–79.
- Melika G, Pujade-Villar J, Stone GN, Fülöp D & Péntzes Zs. 2009. New species of cynipid gallwasps of the genus *Plagiotrochus* Mayr, 1881 from Nepal and Jordan (Hymenoptera: Cynipidae: Cynipini). *Acta Zoologica Academiae Scientiarum Hungaricae*, 55(3): 263–274.
- Melika G, Tang CT, Nicholls J, Yang MM & Stone GN. 2011. Four new species of *Dryocosmus* gall wasps from Taiwan (Hymenoptera: Cynipidae, Cynipini). *ISRN Zoology*, 2011: 1–17. (Article ID 725180)
- Melika G, Tang CT, Sinclair F, Yang MM, Lohse K, Hearn J, Nicholls JA & Stone GN. 2013. A new genus of oak gallwasp, *Cyclocynips* Melika, Tang & Sinclair (Hymenoptera: Cynipidae: Cynipini), with descriptions of two new species from Taiwan. *Zootaxa*, 3630: 534–548.
- Pujade-Villar J, Wang Y, Guo R & Chen XX. 2014. New species of gall wasps inducing in *Quercus fabri* and its inquiline (Hymenoptera: Cynipidae) in China. *Zoological Systematics*, 39(3): 417–423.
- Pujade-Villar J, Wang Y, Tang T, Shen J & Ferrer-Suay M. 2016. *Andricus mukaigawae* and *A. kashiwaphilus* from China with remarks of morphological differences and inquilines (Hymenoptera: Cynipidae). *Butletí*

de la Institució catalana d'Història Natural, 80: 27–24.

- Ronquist F, Nieves-Aldrey JL, Buffington ML, Liu Z, Liljeblad J & Nylander JAA. 2015. Phylogeny, evolution and classification of gall wasps. The plot thickens. *PLoS ONE*, 10(5): e0123301. doi: 10.1371/journal.pone.0123301.
- Ronquist F & Nordlander G. 1989. Skeletal morphology of an archaic cynipoid, *Ibalia rufipes* (Hymenoptera: Ibalidae). *Entomologica Scandinavica*, 33(supplement): 1–60.
- Tang CT, Melika G, Nicholls J, Yang MM & Stone GN. 2011a. A new genus of oak gall wasps, *Cycloneuroterus* Melika & Tang, with the description of five new species from Taiwan (Hymenoptera: Cynipidae: Cynipini). *Zootaxa*, 3008: 33–62.
- Schwéger S, Melika G, Tang CT, Bihari P, Bozsó M, Stone GS, Nicholls JA & Péntes Z. 2015a. New species of cynipid inquilines of the genus *Synergus* (Hymenoptera: Cynipidae: Synergini) from the Eastern Palearctic. *Zootaxa*, 3999(4): 451–497.
- Schwéger S, Melika G, Tang CT, Yang MM, Stone GS, Nicholls JA, Sinclair F, Hearn J, Bozsó M & Péntes Z. 2015b. New species of cynipid inquilines of the genus *Saphonecrus* (Hymenoptera: Cynipidae: Synergini) from the Eastern Palearctic, with a re-appraisal of known species world-wide. *Zootaxa*, 4054(1): 1–84.
- Tang CT, Melika G, Yang MM, Nicholls JA, Csóka GY & Stone GN. 2009. First record of an *Andricus* oak gall wasp from the Oriental Region: a new species from Taiwan (Hymenoptera: Cynipidae: Cynipini). *Zootaxa*, 2175: 57–65.
- Tang CT, Melika G, Yang MM, Nicholls J & Stone GN. 2011b. New species of oak gall wasps from Taiwan (Hymenoptera: Cynipidae: Cynipini). *Zootaxa*, 2865: 37–52.
- Tang CT, Sinclair F & Melika G. 2012a. A new *Latuspina* Monzen oak gall wasp species from Taiwan (Hymenoptera: Cynipidae: Cynipini). *Journal of Asia-Pacific Entomology*, 15: 573–577.
- Tang C T, Sinclair F, Yang MM & Melika G. 2012b. A new *Andricus* Hartig oak gall wasp species from China (Hymenoptera: Cynipidae: Cynipini). *Journal of Asia-Pacific Entomology*, 15: 601–605.
- Wang J, Cui J, Wu SA & Pujade-Villar J. 2016. Description of the sexual generation of *Trichagalma acutissimae* (Hymenoptera: Cynipidae) and notes on its heterogonic life cycle. *Journal of Asia-Pacific Entomology*, 19: 405–413.
- Wang Y, Guo R & Chen X. 2013. A new species of *Andricus* oak gall wasp from China (Hymenoptera: Cynipidae: Cynipini). *Biologia*, 68(5): 974–978.
- Wiebes-Rijks AA. 1980. The identity of the gall wasp causing stunted acorns (Hymenoptera, Cynipidae). *Netherlands Journal of Zoology*, 30(2): 243–253.
- Zhu DH, Liu Z, Lu PF, Yang XH, Su CY & Liu P. 2015. New gall wasp species attacking chestnut trees: *Dryocosmus zhuili* n. sp. (Hymenoptera: Cynipidae) on *Castanea henryi* from Southeastern China. *Journal of Insect Science*, 15(1): 156; doi: 10.1093/jisesa/iev118